# NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering ghrand Washington, D.C. 20594

February 19, 2002

Flight Path Study - United Airlines Flight 93

### A. SUBJECT AIRCRAFT

Location:

Shanksville, PA

Date:

September 11, 2001

Time:

10:03 AM Eastern Daylight Time

Flight:

United Airlines Flight 93

Aircraft:

Boeing 757-200, registration: N591UA

NTSB#:

DCA01MA065

#### B. GROUP

N/A

#### C. SUMMARY

This document provides a brief description of the flight path of the aircraft based on information obtained from various sources of recorded radar of the subject aircraft both before and after the hijacking events. Information from the Flight Data Recorder (FDR) recovered on scene is also used to develop the description. Flight paths are overlaid onto maps of the area, and time histories of altitude data are presented

## United Airlines Flight 93 - Flight Profile

The following profile of United Airlines Flight 93 is based on data from the flight data recorder (FDR) recovered from the crash site, as well as radar data obtained from the Federal Aviation Administration's Air Route Traffic Control Centers and the U.S. Air Force 84<sup>th</sup> Radar Evaluation Squadron.

Figure 1 shows the flight path of the aircraft from take off at Newark, NJ to the crash site near Johnstown, PA. Figure 2 shows the aircraft's altitude profile for the 1 hour and 21 minute duration of the flight.

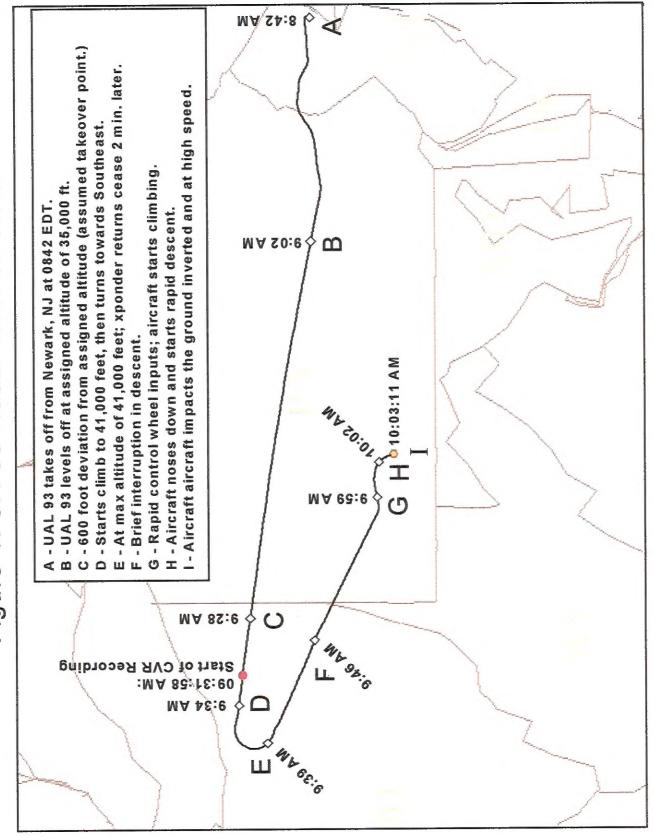
United flight 93 departed Newark, NJ at 8:42 am (point A in Figures 1 and 2) and reached its assigned cruising altitude of 35,000 feet at about 9:02 am (B). The flight appears normal until a brief descent of about 600 feet starting at 9:28 (C). The words "get out of here" and sounds of a struggle were recorded on the air traffic control radio at FAA's Cleveland Center facility at this time. The Cockpit Voice Recorder (CVR) onboard the airplane began providing sounds from the cockpit at approximately 9:32. At 9:34 (D) the airplane starts to climb from 35,000 feet, and shortly thereafter begins a left turn to a Southeast heading of 120° with the autopilot in heading select mode. The airplane maintained a maximum altitude of 41,000 feet for about 2 minutes and then started descending at about 9:39 (E), with the autopilot in vertical speed mode and at a descent rate of 4,000 feet/minute. Radar stations stopped receiving transponder returns from UAL93 at approximately 9:41.

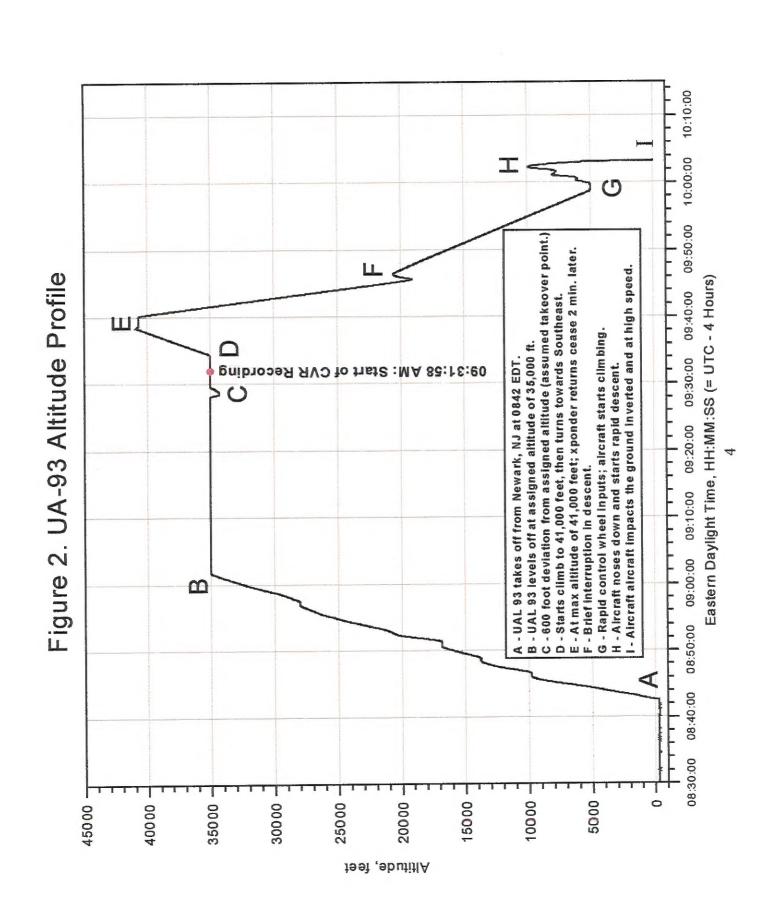
There was a brief interruption in the descent at 9:46 (F) as the airplane climbed from 19,000 feet to 20,500 feet before resuming its descent, but at a slower rate (1,300 feet/minute). At about 9:57 the airplane started a left turn to the east. At 9:59 (G) the airplane was at 5,000 feet when about 2 minutes of rapid, full left and right control wheel inputs resulted in multiple 30 degree rolls to the left and right. From approximately 10:00 to 10:02 there were four distinct control column inputs that caused the airplane to pitch nose-up (climb) and nose-down (dive) aggressively. During this time the airplane climbed to about 10,000 feet while turning to the right. The airplane then pitched nose-down and rolled to the right in response to flight control inputs, and impacted the ground at about 490 knots (563 mph) in a 40 degree nose-down, inverted attitude. The time of impact was 10:03:11.

Jim Ritter

Chief, Vehicle Performance Division NTSB

Figure 1. UA-93 Radar Ground Track





8:41:49 LC	United ninety three wind three three zero at seven runway four left cleared
0.41.40 20	for takeoff, [EWR 1235-1247 LC]
8:41:53 UAL-93	cleared takeoff four left United ninety three. [EWR 1235-1247 LC]
8:42:07 LC	United ninety three. [EWR 1235-1247 LC]
8:42:41 LC	United ninety three contact departure. [EWR 1235-1247 LC]
8:42:43 UAL-93	going to departure United ninety three good day. [EWR 1235-1247 LC]
8:43:00 UAL-93	United ninety three fourteen hundred for twenty five hundred. [N90 1238-
	1256 Newark Dept.] United ninety three New York departure good morning radar contact climb
8:43:04 E155	and maintain eight thousand and turn left heading three three zero vector
	for ELIOT. [N90 1238-1256 Newark Dept.]
8:43:12 UAL-93	eight thousand heading three three zero for ELIOT United ninety three.
0.43, 12 UAL-93	N90 1238-1256 Newark Dept.
8:43:48 E155	United ninety three turn left heading uh two eight zero. [N90 1238-1256
	Newark Dent 1
8:43:52 UAL-93	left two eighty United ninety three. [N90 1238-1256 Newark Dept.]
8:44:34 E155	United ninety three climb and maintain one zero thousand. [N90 1238-1256
	Newark Dept.]
8:44:38 UAL-93	climb and maintain one zero thousand ten thousand United ninety three.
0.45.40 5455	[N90 1238-1256 Newark Dept.] United ninety three do not exceed two five zero knots. [N90 1238-1256
8:45:10 E155	Newark Dept.]
8:45:13 UAL-93	not exceed two fifty United ninety three. [N90 1238-1256 Newark Dept.]
8:45:54 E155	United ninety three resume normal speed contact departure one three five
0.10.01 = 100	noint three five IN90 1238-1256 Newark Dept.]
8:46:00 UAL-93	one three five three five normal speed good day United ninety three. [N90]
	1238-1256 Newark Dept.]
8:46:18 UAL-93	United ninety three is with you one zero thousand, normal speed, heading
0.40.00 D40	two eighty. [N90 1238-1256 Liberty West] United ninety three departure good morning, climb maintain one four
8:46:23 B43	thousand IN90 1238-1256 Liberty Westl
8:46:26 UAL-93	climb maintain one four thousand United ninety three. [N90 1238-1256
0.10.20 0.12	Liberty West1
8:48:03 B43	United ninety three right turn heading of ah three one zero. [N90 1238-1256
	Liberty West]
8:48:07 UAL-93	right heading three one zero United ninety three. [N90 1238-1256 Liberty
0.40.44.040	West] United ninety three climb maintain one six thousand. [N90 1238-1256
8:48:41 B43	Liberty West]
8:48:44 UAL-93	climb maintain one six thousand United ninety three. [N90 1238-1256
0.40.44 OAL 00	Liberty West
8:49:31 B43	United ninety three climb maintain one seven thousand go direct ELIOT on
	course. [N90 1238-1256 Liberty West]
8:49:35 UAL-93	
0.50.07.540	1256 Liberty West] United ninety three contact New York center one three two point one good
8:50:37 B43	day. [N90 1238-1256 Liberty West]
8:50:41 UAL-93	Thing 1 the transfer of the tr
8:50:57 UAL-93	
0.00.07 OAL-90	1245-1258 R391
8:51:03 R39	United ninety three New York center climb and maintain flight level two
	eight zero 17NY 1245-1258 R391
8:51:07 UAL-93	maintain two eight oh United ninety three. [ZNY 1245-1258 R39]
8:54:09 R39	United ninety three cleared direct DEMO. [ZNY 1245-1258 R39]
8:54:12 UAL-93	direct DEMO United ninety three. [ZNY 1245-1258 R39]

8:54:53 R39	United ninety three contact New York center one three three point four correction New York center one thirty two eighty seven. [ZNY 1245-1258
8:54:59 UAL-93	R39] one thirty two eighty seven good day United uh ninety three. [ZNY 1245-1258 R39]
8:55:05 UAL-93	good morning New York United ninety three with you twenty five and a half
8:55:09 R73	United ninety three New York center good morning. [ZNY 1250-1320 R73]
8:57:12 R73	United ninety three climb and maintain flight level three five zero. [ZNY
0.57.12 1075	1250_1328 R73
8:57:16 UAL-93	leaving two eight for three five oh United ninety three. [ZNY 1250-1328 R73]
9:22:20 UAL-93	United ninety three starting to pick up some light chop at thirty five, any nice
9:22:26 RA73	the ah first complained I've had and United ah ninety three, contact the Cleveland center now on one three three point zero seven. [ZNY 1308-1328 RA73]
9:22:37 UAL-93	thrity three oh seven United ninety three. [ZNY 1308-1328 RA73]
9:23:00 ACARS	BEWARE ANY COCKPIT INTROUSION TWO AIRCRAFT IN NY, HIT
	TRADE CNTER BUILDS
9:23:05 UAL-93	morning Cleveland it's United ninety three with you at three five oh ah there's some light chop here at thirty five any ride reports? [ZOB 13:01-
	13:31 Franklin-R]
9:23:14 FKL-R	an no just a little light chop nothing worse than that United ninety three.
9:23:56 FKL-R	United ninety three Cleveland one three three seven. [ZOB 1301-
9:24:00 UAL-93	one three three seven good day United ninety three. [ZOB 1301-1331
9:24:20 UAL-93	good morning Cleveland United ninety three is with you at three five oh intermittent light chop. [ZOB 1314-1333 Lorain-R]
9:25:06 UAL-93	United ninety three checking in three five oh. [ZOB 1314-1333 Loralli-K]
9:25:08 LOR-R	United ninety three three five zero roger. [ZOB 1314-1333 Lorain-R]
9:27:25 LOR-R	United ninety three that traffic for you is one o'clock twelve miles east
9:27:30 UAL-93	bound three seven zero. [ZOB 1314-1333 Lorain-R] negative contact we're looking United ninety three. [ZOB 1314-1333
9:28:16 UAL-93	Lorain-R] *** (mayday) *** (hey get out of here) ***. [ZOB 1314-1333 Lorain-R]
9:28:48 UAL-93	*** (get out of here) *** (get out of here). [ZOB 1314-1333 Lorain-R]
9:29:14 LOR-R	I Inited ninety three verify three five zero. [ZOB 1314-1333 Lorain-N]
9:29:20 LOR-R	United ninety three verify you're at flight level ah three five zero. [ZOB
0.20.20	1314-1333 Lorain-RI
9:29:34 LOR-R	United ninety three verify you're level at three five zero. [ZOB 1314-1333 Lorain-R]
9:29:40 LOR-R	United ninety three Cleveland. [ZOB 1314-1333 Lorain-R]
9:29:56 LOR-R	United ninety three Cleveland. [ZOB 1314-1333 Lorain-R]
9:30:03 LOR-R	United ninety three if you hear Cleveland center ident please. [ZOB 1314-1333 Lorain-R]
9:30:58 LOR-R	Lorain-R]
9:31:55 UAL-93	*** [ZOB 1314-1333 Lorain-R]
9:32:05 LOR-R	121/_1223   orain_R1
9:35:36 LOR-R	ah United ninety three if able * ah squawk trip please. [ZOB 1333-1344

	Lorain-R]
9:36:51 LOR-R	[Cleveland center announces that UAL93 is turning south and east and climbing]. [ZOB 1333-1344 Lorain-R]
9:39:10 UAL-93	ah this is the captain uh would like to all remain seated there is a bomb aboard and we go back to the airport and to have our demands so please remain quiet. [ZOB 1333-1344 Lorain-R]
9:39:19 LOR-R	okay thats United ninety three calling? [ZOB 1333-1344 Lorain-R]
9:39:24 LOR-R	United ninety three understand you have a bomb on board go ahead. [ZOB 1333-1344 Lorain-R]
9:40:04 LOR-R	United ninety three go ahead. [ZOB 1333-1344 Lorain-R]
9:40:12 LOR-R	United ninety three go ahead. [ZOB 1333-1344 Lorain-R]
9:41:01 LOR-R	United ninety three do you hear Cleveland center? [ZOB 1333-1344 Lorain-R]
9:41:36 LOR-R	[Cleveland center announces loss of transponder signal from UAL93] [ZOB 1333-1344 Lorain-R]
9:45:29 LOR-R	United ninety three Cleveland do you still hear the center? [ZOB 1344-1400 Lorain-R]
9:45:35 LOR-R	United ninety three do you still hear Cleveland? [ZOB 1344-1400 Lorain-R]
9:46:13 LOR-R	United ninety three United niner three do you hear Cleveland? [ZOB 1344-1400 Lorain-R]
9:47:28 LOR-R	United ninety three United ninety three Cleveland. [ZOB 1344-1400 Lorain-R]
9:48:39 LOR-R	United ninety three United ninety three do you hear Cleveland center. [ZOB 1344-1400 Lorain-R]